AD-A121 732 ZIP II POST FLIGHT REPORT (FLIGHT A246S-1-2)(U) SPACE 1/1
VECTOR CORP NORTHRIDGE CA R E SCARBORO 30 OCT 81
AFGL-TR-82-0156 F19628-77-C-0257

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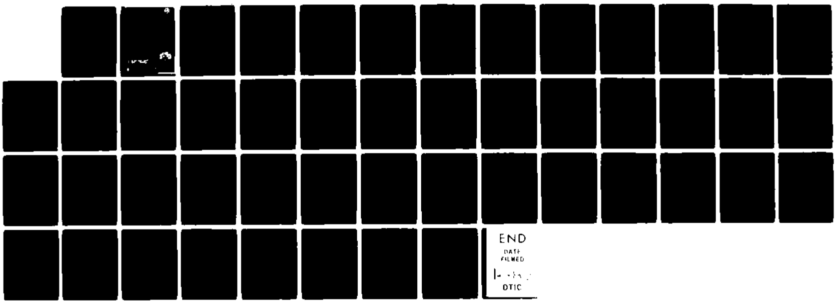

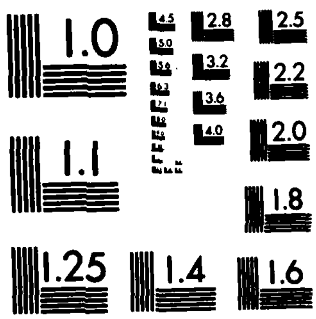

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# REPORT DOCUMENTATION PAGE

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ARIES
ZIP II

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Under the cognizance of the Air Force Geophysics Laboratory, an ARIES, designated Flight No. A24.6S1-2, was launched from White Sands Missile Range on July 31, 1981. This report provides a general summary of the vehicle, Booster data, heat sink data, flight performance analysis, and booster impact prediction data.

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## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

## SECTION 1.0

## GENERAL SUMMARY

1.1 Under the cognizance of the Air Force Geophysics Laboratory, an ARIES, designated Flight No. A24.6S1-2, was launched at 0400 hours (MST) on 31 July 1981 from White Sands Missile Range.

1.2 The vehicle had a gross liftoff weight of 13,889 pounds. Separated payload weight was 1,256 pounds and recovery weight was 1,212 pounds. The M56A-1 booster produced a burnout velocity of 8,027 fps, (2,539 mps) lifting the payload to an apogee of 244.4 miles. Zenith altitute was reached at 337 seconds into the flight and the payload was at an altitude greater than 300K feet for approximately 525 seconds.

1.3 The boost phase of the flight was successful with the guidance system maintaining the vehicle in a stable attitude.

1.4 The payload/booster delta velocity system functioned properly, producing a stable separation with a final separation velocity of 13-14 fps. The nose tip ejection system also functioned properly at the scheduled time during the rentry phase resulting in a successful recovery.

1.5 An overall vehicle description is presented in Figure 1-1 and a Flight Summary is presented on Table 1-1.

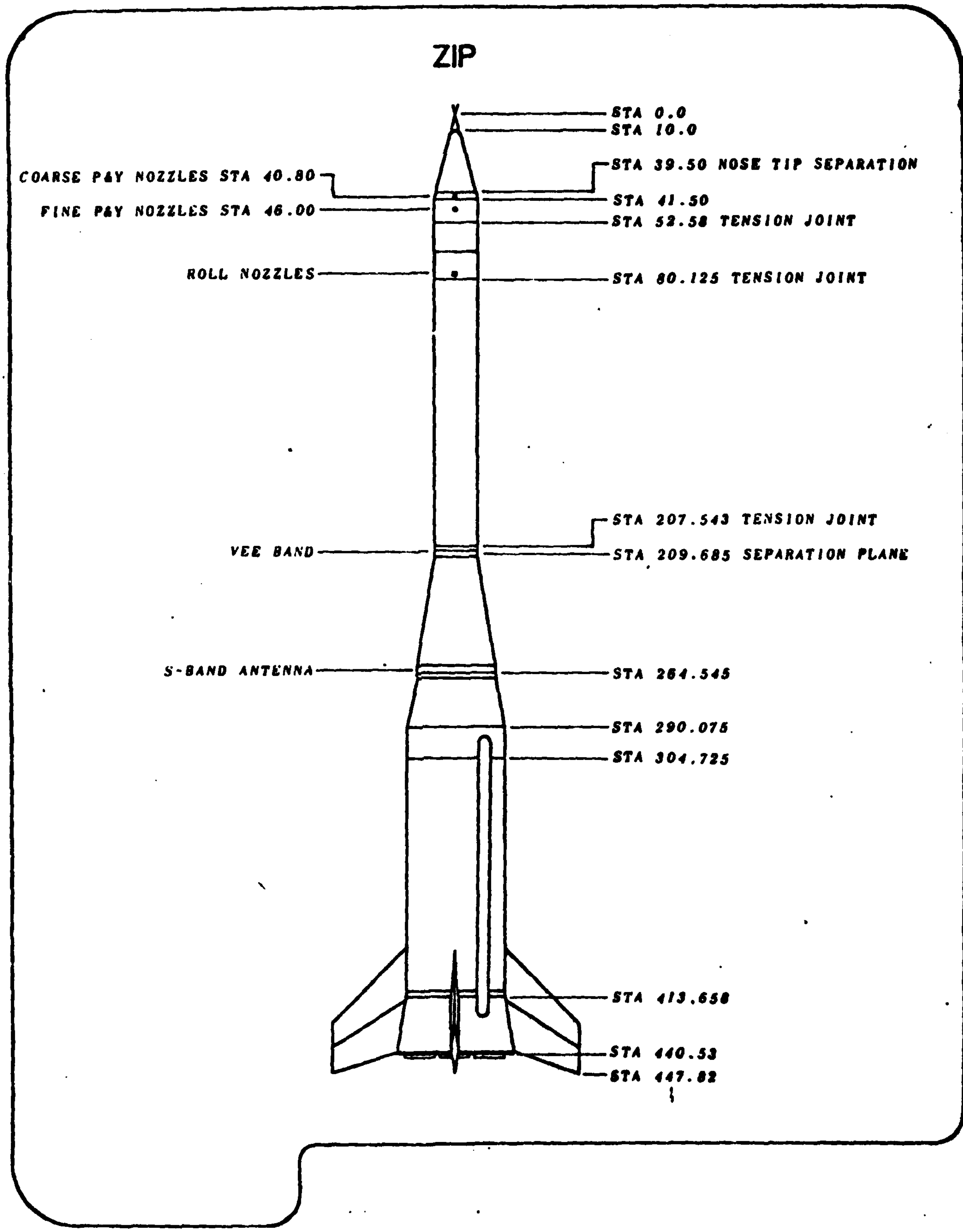

ZIP
STA 0.0
STA 10.0
COARSE P&Y NOZZLES STA 40.80
STA 39.50 NOSE TIP SEPARATION
STA 41.50
FINE P&Y NOZZLES STA 46.00
STA 52.58 TENSION JOINT
ROLL NOZZLES
STA 80.125 TENSION JOINT
STA 207.543 TENSION JOINT
VEE BAND
STA 209.685 SEPARATION PLANE
S-BAND ANTENNA
STA 264.545
STA 290.075
STA 304.725
STA 413.658
STA 440.53
STA 447.82

Fig. 1-1

TABLE 1-1

ZIP II FLIGHT SUMMARY

| | |
|---|---|
| Vehicle Identification | A24.6S1-1 |
| ARIES Model Number | 11740 |
| M56A-1 Booster Serial Number | 22770 |
| Launch Date/Time | 31 Jul 81/0400 MST |
| Launch Site | WSMR/LC36 |
| Vehicle Launch Azimuth (Pitch Plane) | 004° True |
| Vehicle Launch Angle | Vertical |
| Vehicle Gross Liftoff Weight | 13.889.2 Pounds |
| Separated Payload Weight | 1,256.5 Pounds |
| Recoverable Payload Weight | 1,212.5 Pounds |
| Vehicle Overall Length | 437.82 Inches |
| Peak Longitudinal Acceleration | 8.1 g's |
| Burnout Time | 60.3 Seconds |
| Burnout Velocity | 8027 FPS |
| Burnout Altitude | 171,441 Feet (32.4 Miles) |
| Predicted Apogee Altitude | 1,257,373 Feet (238.2 Miles) |
| Actual Apogee Altitude | 1,290,560 Feet (244.4 Miles) |
| Predicted Apogee Time | 329.8 Seconds |
| Actual Apogee Time | 337.3 Seconds |
| Predicted Booster Impact Time | 603 Seconds |
| Actual Booster Impact Time | 767 Seconds |

TABLE 1-1

NOTE

## SECTION 2.0

## BOOSTER DATA

2.1 Booster Serial Number 22770 was flown on the ZIP II Campaign. It performed within the predicted specifications established by the Aging and Survelliance Program which is administired by Hill Air Force Base. A performance summary is presented on Table 2-1 and Figure 2-1.

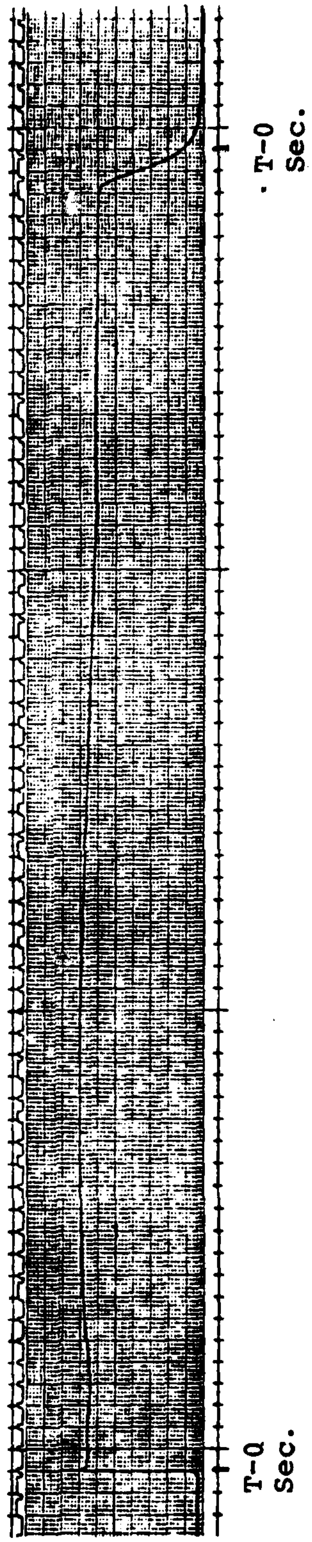
2.2 The booster was prepared for flight at Hill Air Force Base facilities in the beginning months of 1981 and was accepted for flight on 3 March 1981. The Booster was then shipped to White Sands Missile Range were it remained in storage until July 1981. A copy of the Certificate of Acceptance is presented in Figure 2-2.

2.3 This Booster remained in a temperature controlled environment until its launch on 31 July 1981. A copy of the temperature records for the last seven days it was on the launch pad is presented on Figure 2-3.

## TABLE 2-1

### BOOSTER DATA SUMMARY

| | |
|---|---|
| Serial Number | 22770 |
| Type | M56A-1 |
| Date Propellant Casted | 11 June 64 |
| Date of Booster Buy-off | 3 Mar 81 |
| Nozzle Ratio | 11.8:1 |
| Ignition Delay | .1 Seconds |
| Max $P_c$ | +14/+21 Sec $\pm$517 PSIA |
| Decay $P_c$ | 59.5 Seconds |
| Burnout | 61.5 Seconds |




Motor Chamber Pressure

0-750 PSIA

Fig. 2-1

# CERTIFICATE OF ACCEPTANCE

The undersigned certify that Second Stage Motor S/N 22770

meets the criteria established in the Air Force Geophysics Laboratory Booster Refurbishment and Configuration Baseline Requirements Document and is accepted for use as an ARIES booster.

This certification is valid for 12 months after receipt of booster at its launch location.

E. P. McKenna — 3 Mar 81

AFGL/LCR — Date

— 3 MAR 81.

Space Vector Corporation — Date

Kenneth G. Cole-SD — 3 Mar 81

Space Division

— 3 Mar 81

Aerospace

The following waivers were granted:

1. NCU BATT. HAS ONLY 6 MOS REMAINING ON SERVICE LIFE. (REF. PAGE 4).

2. FWD "Y" JOINT NOT X-RAY EVERY 15° (REF PAGE 3)

AFGL BOOSTER REFURBISHMENT AND CONFIGURATION

BASELINE CERTIFICATION CHECKLIST

STEP S N 22770

DATE 3 MARCH 19

| | SPECIFIC REQUIREMENTS | | ACCEPTANCE CRITERIA | APPLICABILITY INIT. CERT | APPLICABILITY RECERT | COMMENTS |
|---|---|---|---|---|---|---|
| 1. | Review Motor Manufacturer's Log Book | A. | Evaluate all Class I deviations. | OK. | N/A | NO DEVIATIONS. |
| | | B. | Determine casting dates (18 Nov. 63 through 27 Jan. 64 are not to be certified). | OK | N/A | 6-11-64. |
| 2. | Booster Historical Review | A. | Review downstage traceability record. | OK. | N/A | |
| | | B. | Review history of booster since last certified. | N/A | | |
| 3. | Booster Work Control Document (Form 959) | A. | All entries completed. | OK | | |
| | | B. | "P" and "Q" stamps on all required operations. | OK. | | |
| | | C. | Operations completed within 6 months of shipping date. | JAN 81. | | |
| 4. | Booster In-Coming TEMS Data | A. | Temperature limits (+60°F to +100°F). | — | | • NO DATA RECORD. • VERBAL - NO COU |
| | | B. | Transportation limits (<2G transverse or longitudinal). | | | |

AFGL BOOSTER REFURBISHMENT AND CONFIGURATION

BASELINE CERTIFICATION CHECKLIST

... S/N 22770

DATE

| | SPECIFIC REQUIREMENTS | | ACCEPTANCE CRITERIA | APPLICABILITY INIT. CERT. | APPLICABILITY RECERT | COMMENTS |
|---|---|---|---|---|---|---|
| 5. | Booster Visual Inspection (Form 100) | A. | Evaluate all discrepancies noted. | OK | | |
| | | B. | In-coming component record (Form 557). | OK. | | |
| 6. | Leak Test/In-Coming (Form 557) | A. | Evaluate an out of tolerance condition (<1.0 ounces per year). | OK. | N/A | |
| 7. | Borescope Inspection (Form 557) | A. | Evaluate data recorded (T.O. 33B4-2-11-1). | OK. | | |
| 8. | Igniter Port Forward Boot Gap Inspection (SVC Dwg) | A. | Evaluate data (<.75 maximum allowed). | OK. | | |
| 9. | Nozzle Torque and Deflection (Form 557) | A. | Evaluate data - 2 required (42 ft/lbs maximum). | OK | | |
| | | B. | "Q" stamp required. | OK. | | |
| 10. | Nozzle Cut-Off (Form 557) | A. | Evaluate data (11.8:1 expansion ratio, throat = 4.28/4.30, exit = 14,915/14.88). | — | N/A | NO DATA SHEET. VERBAL REPORT 14.8 |
| | | B. | S/N on outgoing component record (Form 557). | OK | N/A | |

AFGL BOOSTER REFURBISHMENT AND CONFIGURATION

BASELINE CERTIFICATION CHECKLIST

BOOSTER S/N 22720 DATE ______

| | SPECIFIC REQUIREMENTS | | ACCEPTANCE CRITERIA | APPLICABILITY INIT. CERT | RECERT | COMMENTS |
|---|---|---|---|---|---|---|
| 11. | Nozzle Alignment (Form 557) | A. | Confirm "X" dimensions are for nozzles installed Reference component records (Form 557). | OK | | |
| | | B. | Confirm alignment tolerance (±.048). | OK | | |
| | | C. | Confirm NCU S/N on component record (Form 557). | 0664. | | |
| | | D. | Confirm "Q" stamp. | OK. | | |
| 12. | Leak Check - Out-Going (Form 557) | A. | Evaluate out of tolerance condition (<1.0 ounce per year). | OK. | | |
| 13. | Motor Radiograph Inspection (Form 432) | A. | Evaluate out of tolerance conditions (2K-SRM56-3). | OK. | | SMALL VOIDS. |
| | | B. | Forward and aft "Y" joint every 15°. | — | | X-RAY EVERY 30° ONLY. |
| 14. | Igniter Radiograph Inspection (Form 432) | A. | Evaluate out of tolerance conditions (2K-SRM56-3). | OK. | | |
| | | B. | P/N 366277-9 required. | -9. | | |

## AFGL BOOSTER REFURBISHMENT AND CONFIGURATION

## BASELINE CERTIFICATION CHECKLIST

TLP S/N 22770

DATE

| | SPECIFIC REQUIREMENTS | ACCEPTANCE CRITERIA | APPLICABILITY INIT. CERT. | APPLICABILITY RECERT | COMMENTS |
|---|---|---|---|---|---|
| 15. | NCU Work Control Document (Form 959) | A. All entries completed. | OK | | |
| | | B. "P" and "Q" stamps on all required entries. | OK | | |
| | | C. Operations completed within 6 months of shipping date. | JAN 81. | | • BATT. HAS 6 MOS REMAINING. |
| 16. | NCU Overhaul (Dart Package) | A. Battery has 12 months remaining life. | — | | • SERV. LIFE 212 MOS. • DATE 13 DEC 63. • EST. LIFE 24 MOS. |
| | JAN 81. Date Complete<br>Note: This overhaul is good for three (3) years. | B. Battery squib check completed. | OK. | | |
| | | C. Nozzle actuators overhauled. | OK | N/A | |
| | | D. Pump/motor overhaul completed. | OK | N/A | |
| | | E. Pump pressure switch test completed. | OK. | N/A | |
| | | F. TVC amplifier overhauled and tested. | OK | N/A | |
| | | G. APS vibration completed. | OK | N/A | |
| | | H. Functional test completed (no leakage). | OK | | |

AFGL BOOSTER REFURBISHMENT AND CONFIGURATION

BASELINE CERTIFICATION CHECKLIST

STEP S/N 22770 DATE

| | SPECIFIC REQUIREMENTS | ACCEPTANCE CRITERIA | APPLICABILITY INIT. CERT | RECERT | COMMENTS |
|---|---|---|---|---|---|
| | | I. Filter test completed. | OK | | |
| | | J. Confirm "Q" stamp for final close up. | OK | | |
| | | K. All component S/Ns recorded. | OK | | |
| 17. | Safe and Arm Work Control Document (Form 959) | A. All entries completed. | OK | | |
| | | B. "P" and "Q" stamp on all required entries. | OK | | |
| | | C. Operations completed within 6 months of shipping date. | JAN 81 | | |
| | | D. P/N KR80000-09 only. | -09 | | |
| | | E. S/N below 27605 only. | 23789 | | |
| | | F. 30V test 1. Limits for Step 1 and 13 is 11 to 30 ohms. | OK | | |
| | | G. Visual inspection completed (Form ~~1007~~ 959). | OK | | • FORM 959 NOT IN PACKAGE. |
| | | H. Bench test completed (Form ~~600E~~ 959). | O.K. | | |

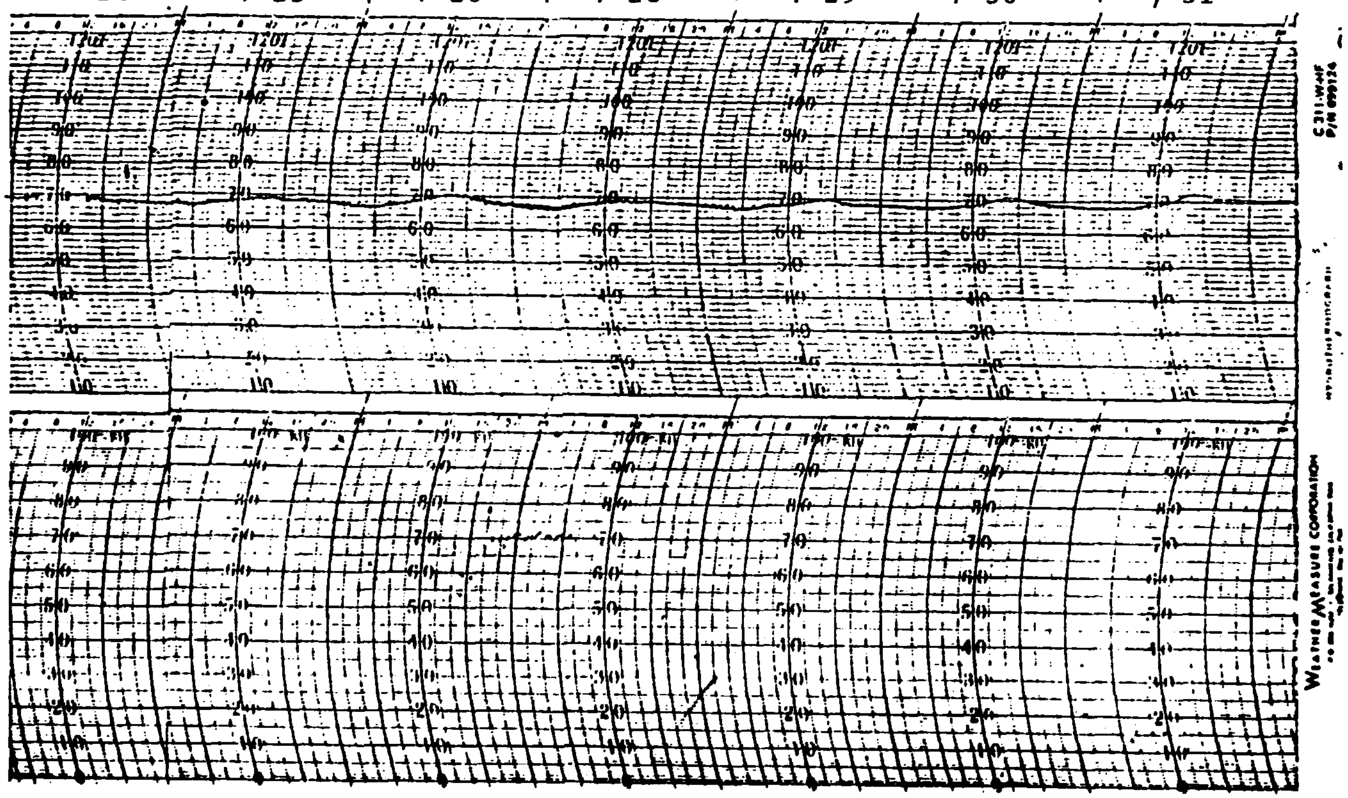
## AFGL BOOSTER REFURBISHMENT AND CONFIGURATION

## BASELINE CERTIFICATION CHECKLIST

BOOSTER S/N 22770 DATE ____

| | SPECIFIC REQUIREMENTS | ACCEPTANCE CRITERIA | APPLICABILITY INIT. CERT. | APPLICABILITY RECERT | COMMENTS |
|---|---|---|---|---|---|
| | | I. Installed to igniter using fixture. No gap after torquing. "Q" stamp required. | OK. | | |
| 18. | OPT Inspection (Form 679) | A. Bench test completed (Form 600E). | OK. | | |
| | | B. Calibration completed (Form 679). | OK. | | |
| | | C. Operations completed within 6 months of shipping date. | JAN 81 | | |
| 19. | NCU Heat Shield | A. Not installed. | OK. | N/A | |
| 20. | TEMS Installed for Transportation | A. Confirm. | | | |
| 21. | Out-Going Inspection Record | A. S/N of all installed components. | OK. | | |
| 22. | Additional Requirements (List Below) | A. Confirm completion as required. | NONE | | |

DATE: 7-24 | 7-25 | 7-26 | 7-28 | 7-29 | 7-30 | 7-31




BOOSTER TEMPERATURE CONDITIONINGS
T-7 DAYS THRU T-O DAYS

Fig. 2-3

## SECTION 3.0

## HEAT SINK

3.1 A heat sink SVC P/N 11008, was flown on the forward dome of the motor. The heat sink was assembled to the motor dome on 31 June 1981. Assembly Data is shown in Figure 3-1.

Twenty-one thermistors were installed as indicated in Figure 3-2 and Table 3-1. Average valves of the heat sink and TC-5 thickness are also shown in Table 3-1. The specific installation data for the inner, middle, and outer ring is presented in Figure 3-1.

3.2 The heat sink instrumentation system was designed and provided by Wentworth Institute. The system consisted of a commuter, resistor bridge, +5VDC power supply and twenty-one (21) GA51J11 Fenwal thermistors. Space Vector provided the mounting hardware in the interstage.

3.3 Digital reduction of the telemetered voltages is presented in Table 3-2 with a conversion from degrees C to degrees $F_3$ and a Delta Rise analysis. The +60 second flight point has historically been used as a convenient maximum temperature point.

3.4 The dome temperature rise for ZIP II is compared to previous flight data in Table 3-3.

| NEXT ASSY | USED ON | LTR | DESCRIPTION | DATE | APPROVED | |
|---|---|---|---|---|---|---|
| | 10830 | - | Prod Rel | 7 FEB 77 | GK | GK |
| | | A | SEE DCN | 4-20-78 | | GK |

| | | | |
|---|---|---|---|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ± | CONTRACT NO. | | SPACE VECTOR Corporation NORTHRIDGE, CALIFORNIA SVC |
| | APPROVALS | DATE | |
| | DRAWN R.O. | 7 FEB 77 | FIELD OPERATION |
| MATERIAL | CHECKED GK | 7 FEB 77 | HEAT SINK INSTALLATION |
| | D. Konstani | 7 FEB 77 | |
| FINISH | | | SIZE A · CODE IDENT NO. 54459 · DRAWING NO. 90113 · A |
| DO NOT SCALE DRAWING | | | SCALE · SHEET 1 OF 6 |



Fig. 3-1

1.0 SCOPE

This document describes the installation procedure to be followed to mount the heat sink, part no. 11008, on the M56A1 motor dome.

2.0 DOCUMENTS AND MATERIALS REQUIRED

2.1 Drawing number: 11008 Heat Sink

2.2 Materials:

1. MEK or equivalent
2. TC-5 Eccotherm
3. S-11 Eccosil primer
4. Vendor: Emerson & Cummings, Inc.
   Canton, MA

2.3 Tools:

1. Wide blade putty knife
2. 60942 Template, radius marking
3. 60943 Spatula, dome contour
   contour no. 1
   contour no. 2
   contour no. 3
4. 60944 Spatula, tile contour
   contour no. 1
   contour no. 2
   contour no. 3
5. Vernier calipers or depth mic.

3.0 PREPARATION

3.1 Clean surface of heat sink and dome with MEK or equivalent.

3.2 Mark dome with ink pen indicating $0^{o}$ radial. OD of heat sink to be marked on dome to establish thermistor location (use radius marking template, P/N 60942 to approximate 5.00, 9.25 and 12.12 radii).

4.0 THERMISTOR INSTALLATION

4.1 Install thermistors along outer edge of circumferential lines using high temperature adhesives:

1. Eccobond 286 for adherence to dome.

## 5.0 HEAT SINK INSTALLATION

5.1 Prime heat sink and dome by wiping with S-11 primer.

5.2 Load pressure cartridge with TC-5. Apply TC-5 to area around igniter boss to 5.00 inch radius line. Use spatula to smooth TC-5 onto dome using high pressure until entire area is covered. Use 60943, no. 1 spatula to smooth TC-5 to required thickness. Spatula to be held vertical to surface and at right angle to ignitor boss. A smooth continuous surface approximately 0.025 inch thick is required.

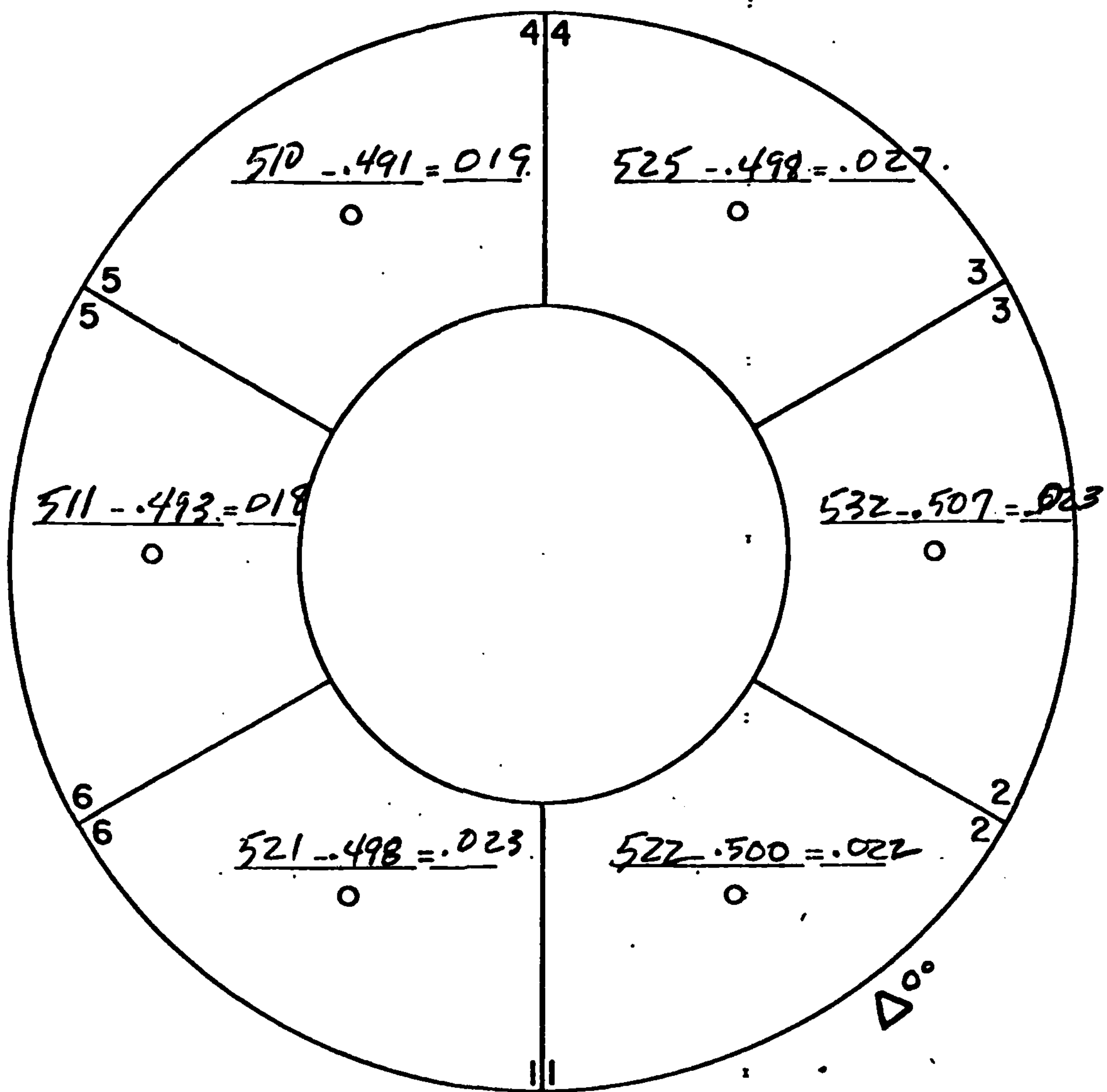
5.3 Apply TC-5 to "inner" tiles and smooth with spatula. Contour TC-5 using tool 60944, no. 1. Surface to be smooth and continuous.

5.4 Apply each tile with a circumferential motion and with significant pressure. Each tile is marked with sequence numbers: 1-2, 2-3, 3-4, 4-5, 5-6 and 6-1. Orientation with reference to "$0^{o}$" to be noted on Figure 1. Depth of TC-5 to be determined with depth gauge through center hole. Tile thickness and depth to be subtracted to determine thickness of TC-5. Record value on Figure 1 (tile thickness is marked on each tile). TC-5 thickness to be .015-.032 thick.

5.5 Repeat steps 5.1, 5.2 and 5.3 for middle and outer tiles using appropriate tools 60943, no. 2 and 3 spatulas and 60944, no. 2 and 3 spatulas. Record TC-5 thickness values on Figures 2 and 3.

5.6 Install links to maintain tiles in ring.

5.7 Install 0.125 inch thick lead segments in 5.00 and 9.25 inch radius cracks.




AVE. .022

FLIGHT NUMBER ZIP II

SERIAL NUMBER SN 13

Felipe

G. Guise

R. [illegible]

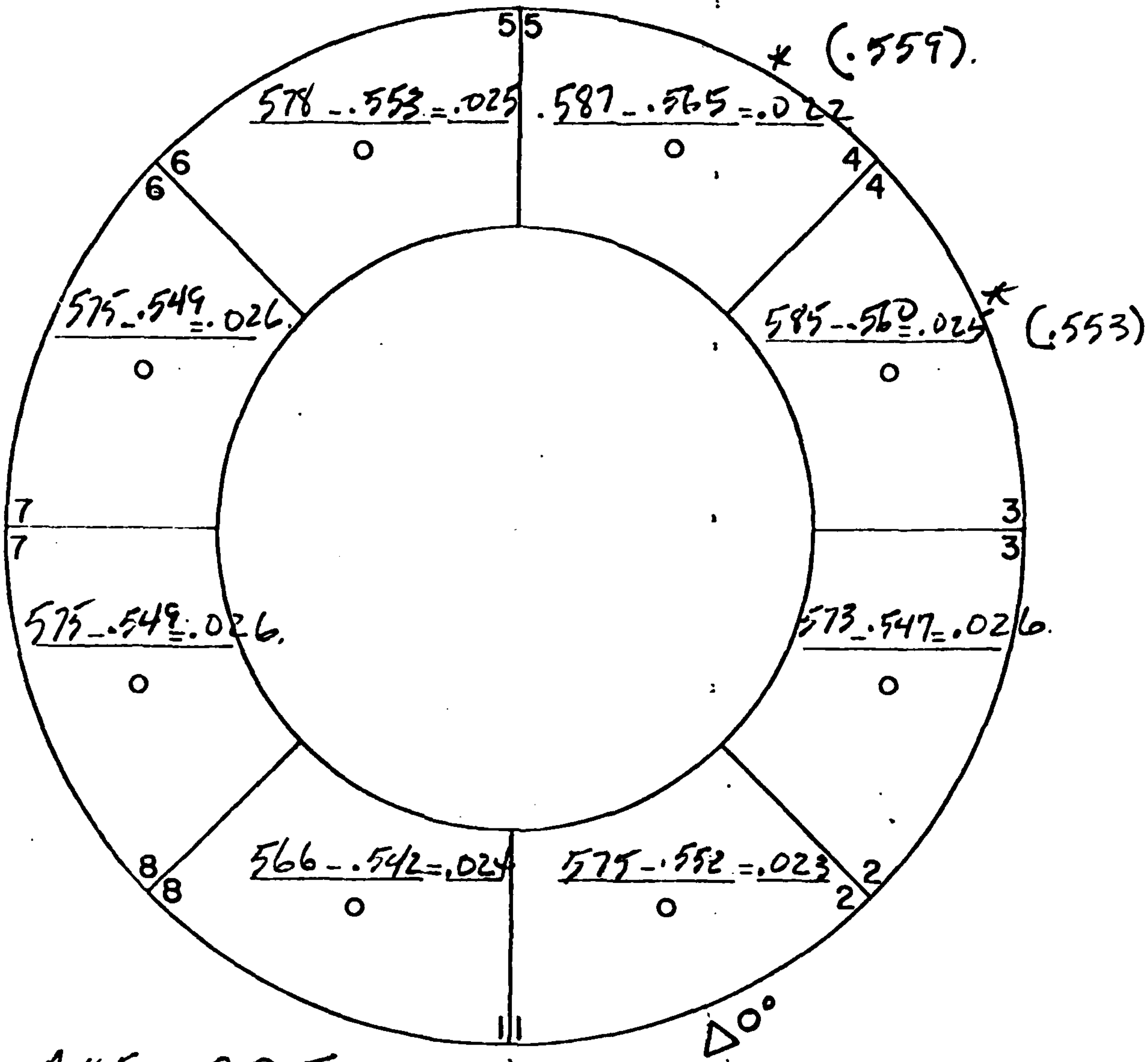
13 JUN 81

## INNER RING

FIGURE I

OVERALL AVE .024

| SIZE | CODE IDENT NO. | DRAWING NO. | |
|---|---|---|---|
| A | 54459 | 90113 | A |
| SCALE | | SHEET 4 OF 6 | |




AVE ..025

FLIGHT NUMBER ________

SERIAL NUMBER SN 13

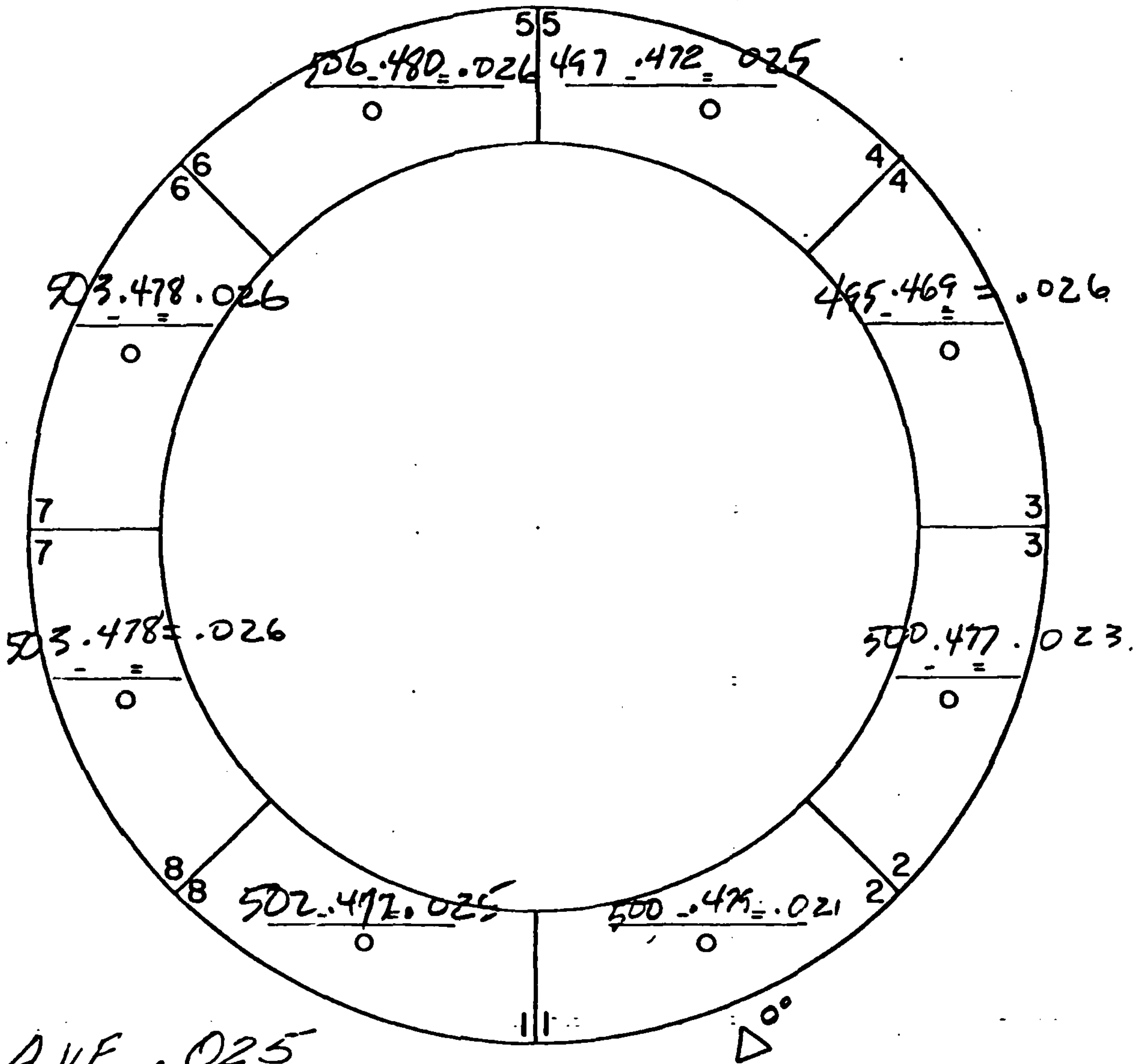
# MIDDLE RING

FIGURE 2

* CORRECTION TO QC READING

Jun 13, 81

| SIZE | CODE IDENT NO. | DRAWING NO. | |
|---|---|---|---|
| A | 54459 | 90113 | A |
| SCALE | | SHEET 5 OF 6 | |




AVE. .025

FLIGHT NUMBER ZIP II

SERIAL NUMBER SN 13

# OUTER RING

FIGURE 3

Felipe
H. Gesi
R. Dunham Jun 13, 81

| SIZE | CODE IDENT NO. | DRAWING NO. | |
|---|---|---|---|
| A | 54459 | 90113 | A |
| SCALE | | SHEET 6 | OF 6 |

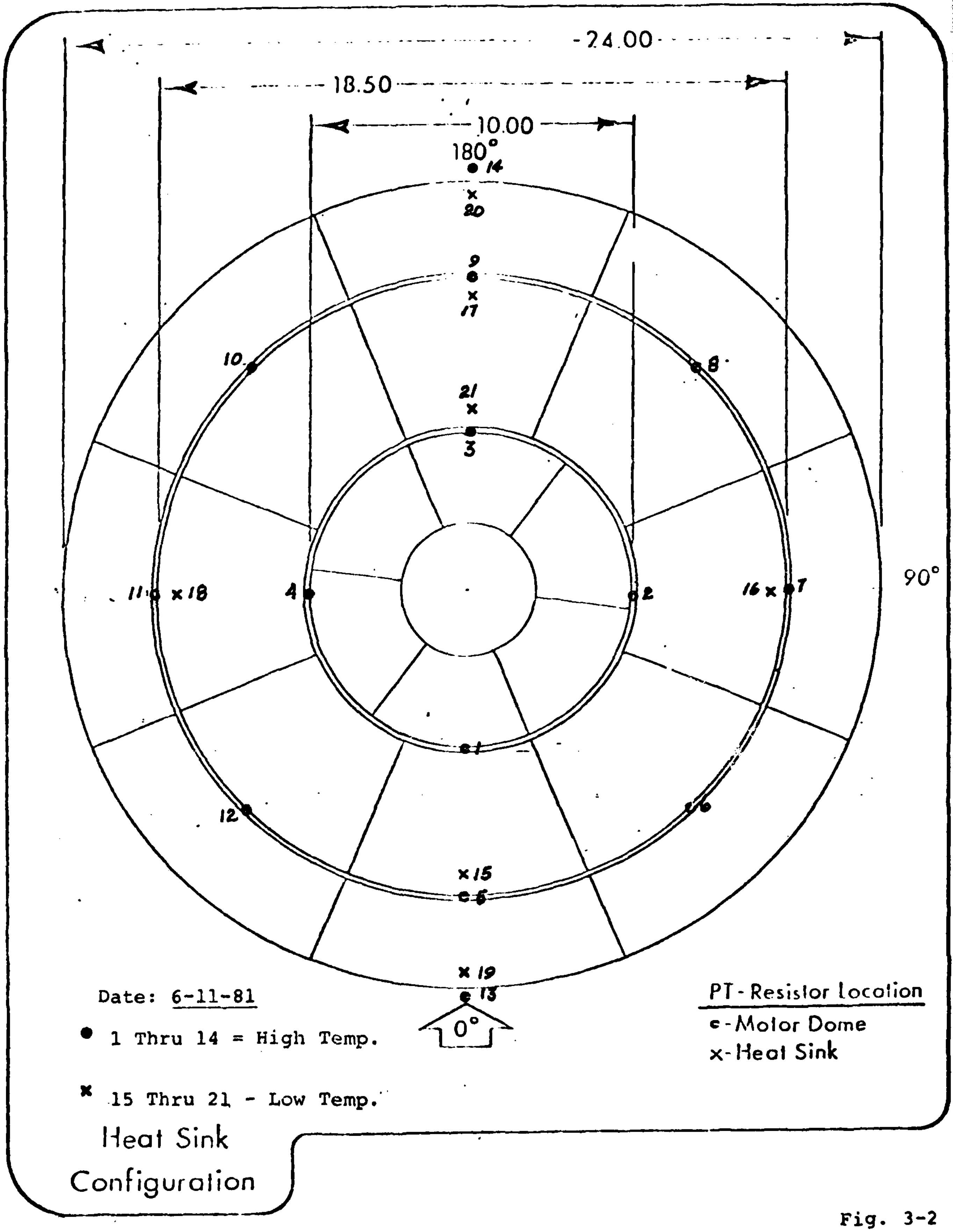

24.00
18.50
10.00
180°
90°
0°
Date: 6-11-81
• 1 Thru 14 = High Temp.
x 15 Thru 21 - Low Temp.
PT-Resistor location
•-Motor Dome
x-Heat Sink
Heat Sink Configuration

Fig. 3-2

TABLE 3-1

| ZIP II Heat Sink Installation | | |
|---|---|---|
| | Average Aluminum Thickness | Average Interface Thickness |
| Inner Ring | .505 in. | .022 in. |
| Middle Ring | .561 in. | .025 in. |
| Outter Ring | .480 in. | .025 in. |

| Sensor Location | | | |
|---|---|---|---|
| Angle (degrees) | Radius (in.) 5 | 9.25 | 12 |
| 0 | 0#1 | 0#5<br>X#15 | 0#13<br>X#19 |
| 45 | | 0#6 | |
| 90 | 0#2 | 0#7<br>X#16 | |
| 135 | | 0#8 | |
| 180 | 0#3<br>X#21 | 0#9<br>0#17 | 0#14<br>0#20 |
| 225 | | 0#10 | |
| 270 | 0#4 | 0#11<br>X#18 | |
| 315 | | 0#12 | |

TABLE 3-2
ZIPII
Dome Temperature at +60 Seconds

| Therm. No. | Deg. C | Deg. F | Delta Rise Deg. F |
|---|---|---|---|
| 1. | 115 | 239.0 | 167.0 |
| 2. | 104 | 219.2 | 147.2 |
| 3. | 122 | 251.6 | 179.6 |
| 4. | 96 | 204.8 | 132.8 |
| 5. | 63 | 145.4 | 73.4 |
| 6. | 82 | 179.6 | 107.6 |
| 7. | 71 | 159.8 | 87.8 |
| 8. | 70 | 158.0 | 86.0 |
| 9. | 70 | 158.0 | 86.0 |
| 10. | 70 | 158.0 | 86.0 |
| 11. | 65 | 149.0 | 77.0 |
| 12. | 85 | 185.0 | 113.0 |
| 13. | 100 | 212.0 | 140.0 |
| 14. | 100 | 212.0 | 140.0 |
| 15. | 52 | 125.6 | 53.6 |
| 16. | 37 | 98.6 | 26.6 |
| 17. | 58 | 136.4 | 64.4 |
| 18. | 40 | 104.0 | 32.0 |
| 19. | 35 | 95.0 | 23.0 |
| 20. | 41 | 105.8 | 33.8 |
| 21. | 42 | 107.6 | 35.6 |
| | | | |

NOTE: A Ambient Temperature of 72° F was used to establish a Delta Rise.

1 Thru 14 = High Temp.
15 Thru 21 = Low Temp.

TABLE 3-3

Comparison of
Motor Dome Temperature Rises ($^{o}$F)

@ T+60 Second
@ 9.25 Inch Radius

| Rocket | Angular Location, DEG | | | |
|---|---|---|---|---|
| | 0 | 90 | 180 | 270 |
| Test Rocket | 253 | 52 | 151 | 83 |
| IMS #3 | 97 | - | 144 | - |
| IMS #4 | 122 | - | 86 | - |
| TEM I | 70 | 34 | 56 | 68 |
| TEM II | 51 | 22 | 28 | 39 |
| ZIP I | 63 | 22 | 18 | 32 |
| IRBS | 99 | 61 | 66 | 72 |
| ZIP II | 73 | 88 | 86 | 77 |

## SECTION 4.0

## FLIGHT PERFORMANCE ANALYSIS

4.1 The boost phase of the flight was successful with all systems functioning properly. Available radar data and telemetry records were used to develop this analysis. A summary is presented in Table 4-1. A pre-launch trajectory is included in Table 4-2.

Table 4-1

Booster Performance

| | Predicted | Actual |
|---|---|---|
| Weight, lbs | 13,893 | 13,889 |
| Velocity @ B.O., ft/sec. | 8,027 | 8,330 |
| Peak altitude, miles | 238 | 244 |
| Impact, miles | | |
| North | 51 | 52 |
| West | 5.2 | 8.2 |

4.2 Telemetry records of the Boost Control System are presented in Figure 4-1 and 4-2. The pitch program followed its pre-programed maneuver throughout the boost phase of the flight. Yaw and roll position data indicate no adverse or unusual maneuvers were experienced during powered flight. Small deviations in the flight path are noted during the coast period between +60 and +80 seconds. A velocity/time plot of the powered flight is presented in Figure 4-3. This plot was developed from radar data.

4.3 Separation of the Booster from the Payload occured at T+80 seconds as programmed. Figure 4-4 and 4-5 depicts the separation distance between the two bodies. Analysis of the accelerometer data indicates that a separation velocity of 13/14 feet per second was obtained. Figure 4-6 is a reproduction of the separation pulse. Analysis of the Radar data

indicates a total separation distance of 2100 feet was obtained in the first 100 seconds aftér separation. This indicates a separation velocity of approximately 21 FPS was imparted by the bellows separation system. Figures 4-4 and 4-5 show this distance. A predicted separation velocity of 32.8 FPS was made prior to the flight.

## TABLE 4-2

ZIP II

04/13/81 03:26 PM PAGE 1

| TIME,SEC | VEL,FPS | ALT,FT | RANGE,FT | MACH | Q,PSF | GMMA,DEG |
|---|---|---|---|---|---|---|
| THRST,LB | WGT,LB | H-DOT | R-DOT | CD | DRAG,LB | THTA,DEG |
| ENRGY,FT | IIP,FT | XDBLDOT | YDBLDOT | CNA | LIFT,LB | ALFA,DEG |
| PATM,PSF | ACCEL,G | GRVTY | IMP,LBSC | DVAERO | DVGRAV | THTA-DOT |
| 0.00 | 0.00 | 4040 | 0 | 0.000 | 0.00 | 0.000 |
| 0 | 13893.00 | 0.00 | 0.00 | 0.237 | 0.00 | 0.000 |
| 4040 | 0 | 0.01 | 0.00 | 0.000 | 0.00 | 0.000 |
| 1819.30 | 0.00 | 32.16 | 0 | 0.00 | 0.00 | 0.000 |
| 0.06 | 0.13 | 4040 | 0 | 0.000 | 0.00 | 0.000 |
| 21574 | 13887.94 | 0.13 | 0.00 | 0.237 | 0.00 | 0.000 |
| 4040 | 0 | 17.82 | 0.00 | 10.240 | 0.00 | 0.000 |
| 1819.30 | 0.55 | 32.16 | 460 | 0.00 | 1.93 | 0.000 |
| 10.00 | 568.59 | 6647 | 69 | 0.521 | 313.95 | 2.141 |
| 39847 | 12196.23 | 568.19 | 21.24 | 0.243 | 806.66 | 2.119 |
| 11676 | 907 | 70.86 | 1.15 | 10.443 | 13.32 | 0.022 |
| 1650.17 | 2.20 | 32.15 | 362180 | 6.05 | 321.51 | 0.040 |
| 20.00 | 1295.53 | 16008 | 468 | 1.230 | 1210.39 | 2.585 |
| 43300 | 10357.22 | 1294.21 | 58.42 | 0.804 | 10278.55 | 2.518 |
| 42164 | 5664 | 70.48 | 0.78 | 13.483 | 203.34 | 0.068 |
| 1142.91 | 2.19 | 32.12 | 778616 | 149.84 | 642.63 | 0.023 |
| 30.00 | 2104.53 | 32776 | 1261 | 2.131 | 1756.57 | 2.805 |
| 44356 | 8530.93 | 2102.01 | 102.99 | 0.558 | 10359.01 | 2.748 |
| 102049 | 16031 | 96.18 | 0.87 | 9.100 | 177.27 | 0.060 |
| 552.49 | 2.99 | 32.07 | 1219318 | 527.67 | 963.29 | 0.023 |
| 40.00 | 3321.17 | 59409 | 2613 | 3.431 | 1279.90 | 3.008 |
| 43838 | 6786.94 | 3316.59 | 174.29 | 0.392 | 5303.42 | 2.978 |
| 233226 | 41377 | 150.73 | 1.32 | 8.146 | 71.17 | 0.037 |
| 155.35 | 4.68 | 31.99 | 1661976 | 859.77 | 1283.24 | 0.021 |
| 50.00 | 5175.39 | 101192 | 4877 | 5.215 | 419.97 | 3.197 |
| 42627 | 5130.46 | 5167.34 | 288.61 | 0.287 | 1274.31 | 3.188 |
| 530046 | 103248 | 227.52 | 1.69 | 6.552 | 11.14 | 0.022 |
| 22.06 | 7.07 | 31.87 | 2090925 | 1018.36 | 1602.10 | 0.021 |
| 59.00 | 7634.30 | 158085 | 8110 | 7.067 | 73.02 | 3.335 |
| 39870 | 3625.88 | 7621.37 | 444.05 | 0.238 | 183.53 | 3.377 |
| 1119484 | 228925 | 320.52 | 1.87 | 5.775 | -1.60 | -0.021 |
| 2.09 | 9.96 | 31.69 | 2467105 | 1055.42 | 1887.70 | 0.021 |
| 60.00 | 7928.39 | 165861 | 8560 | 7.327 | 59.46 | 3.349 |
| 27587 | 3466.50 | 7914.86 | 463.02 | 0.234 | 144.28 | 3.338 |
| 1257270 | 247530 | 223.09 | 1.88 | 5.679 | -1.65 | -0.027 |
| 1.56 | 6.93 | 31.67 | 2503166 | 1056.[illegible] | [illegible] | [illegible] |
| 63.00 | 8027.73 | 189918 | 9563 | [illegible] | [illegible] | 3.335 |
| 0 | 3352.53 | 8013.72 | 473.99 | [illegible] | 60.10 | 3.451 |
| 1261420 | 259022 | -32.12 | 1.90 | 5.535 | -1.25 | -0.049 |
| 0.62 | -1.00 | 31.60 | 2524041 | 1059.68 | 2014.07 | 0.021 |

| TIME.SEC | VEL,FPS | ALT,FT | RANGE,FT | MACH | Q,PSF | GMMA.DEG |
|---|---|---|---|---|---|---|
| THRST.LB | WGT.LB | H-DOT | R-DOT | CD | DRAG,LB | THTA.DEG |
| ENRGY.FT | IIP,FT | XDBLDOT | YDBLDOT | CNA | LIFT.LB | ALFA.DEG |
| PATM.PSF | ACCEL,G | GRVTY | IMP.LBSC | DVAERO | DVGRAV | THTA-DOT |
| 70.00 | 7805.88 | 245234 | 13243 | 8.369 | 2.65 | 3.472 |
| 0 | 3352.53 | 7791.56 | 472.70 | 0.219 | 6.13 | 3.608 |
| 1260966 | 258948 | -31.43 | 1.96 | 5.406 | -0.26 | -0.100 |
| 0.05 | -0.98 | 31.43 | 2524041 | 1061.31 | 2234.28 | 0.000 |
| 30K FT 80.00 | 7493.15 | 321581 | 17898 | 7.952 | 0.04 | 3.604 |
| 0 | 3352.53 | 7478.33 | 470.99 | 0.000 | 0.00 | 3.608 |
| 1260929 | 258942 | -31.15 | 1.94 | 0.000 | 0.00 | 0.045 |
| 0.00 | -0.97 | 31.21 | 2524041 | 1061.45 | 2546.87 | 0.000 |
| 90.00 | 7182.79 | 394808 | 22520 | 7.183 | 0.00 | 3.747 |
| 0 | 3352.53 | 7167.44 | 469.38 | 0.000 | 0.00 | 3.608 |
| 1260929 | 258942 | -30.93 | 1.92 | 0.000 | 0.00 | 0.200 |
| 0.00 | -0.96 | 30.99 | 2524041 | 1061.45 | 2857.23 | 0.000 |
| 100.00 | 6874.57 | 464937 | 27112 | 6.875 | 0.00 | 3.902 |
| 0 | 3352.53 | 6858.63 | 467.84 | 0.000 | 0.00 | 3.608 |
| 1260929 | 258942 | -30.73 | 1.90 | 0.000 | 0.00 | 0.368 |
| 0.00 | -0.95 | 30.79 | 2524041 | 1061.45 | 3165.45 | 0.000 |
| 150.00 | 5361.99 | 769776 | 49661 | 5.362 | 0.00 | 4.935 |
| 0 | 3352.53 | 5342.12 | 461.26 | 0.000 | 0.00 | 3.608 |
| 1260929 | 258942 | -29.88 | 1.81 | 0.000 | 0.00 | 1.463 |
| 0.00 | -0.93 | 29.93 | 2524041 | 1061.45 | 4678.03 | 0.000 |
| 200.00 | 3889.43 | 999763 | 71660 | 3.889 | 0.00 | 6.739 |
| 0 | 3352.53 | 3862.56 | 456.43 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -29.25 | 1.74 | 0.000 | 0.00 | 3.327 |
| 0.00 | -0.90 | 29.31 | 2524041 | 1061.45 | 6150.58 | 0.000 |
| 250.00 | 2451.14 | 1156463 | 93274 | 2.451 | 0.00 | 10.655 |
| 0 | 3352.53 | 2408.88 | 453.19 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -28.84 | 1.69 | 0.000 | 0.00 | 7.302 |
| 0.00 | -0.88 | 28.89 | 2524041 | 1061.45 | 7588.85 | 0.000 |
| 300.00 | 1070.83 | 1240914 | 114654 | 1.071 | 0.00 | 24.936 |
| 0 | 3352.53 | 971.01 | 451.46 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -28.63 | 1.65 | 0.000 | 0.00 | 21.641 |
| 0.00 | -0.81 | 28.67 | 2524041 | 1061.45 | 8968.11 | 0.000 |
| 333.91 | 451.13 | 1257373 | 129091 | 0.451 | 0.00 | 90.000 |
| 0 | 3352.53 | -0.00 | 451.13 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -28.58 | 1.63 | 0.000 | 0.00 | 86.745 |
| 0.00 | 0.00 | 28.63 | 2524041 | 1061.45 | 9589.19 | 0.000 |
| [illegible] | 444.75 | 1253668 | 135939 | 0.445 | 0.00 | 135.589 |
| [illegible] | 3352.53 | -460.57 | 451.20 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -28.59 | 1.62 | 0.000 | 0.00 | 132.353 |
| 0.00 | 0.64 | 28.54 | 2524041 | 1061.45 | 9394.75 | 0.000 |

| TIME,SEC<br>THRST,LB<br>ENRGY,FT<br>PATM,PSF | VEL,FPS<br>WGT,LB<br>IIP,FT<br>ACCEL,G | ALT,FT<br>H-DOT<br>XDBLDOT<br>GRVTY | RANGE,FT<br>R-DOT<br>YDBLDOT<br>IMP,LBSC | MACH<br>CD<br>CNA<br>DVAERO | Q,PSF<br>DRAG,LB<br>LIFT,LB<br>DVGRAV | GMMA,DEG<br>THTA,DEG<br>ALFA,DEG<br>THTA-DOT |
|---|---|---|---|---|---|---|
| 400.00 | 1948.38 | 1194807 | 157269 | 1.948 | 0.00 | 166.574 |
| 0 | 3352.53 | -1895.13 | 452.40 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -28.75 | 1.60 | 0.000 | 0.00 | 163.396 |
| 0.00 | 0.87 | 28.79 | 2524041 | 1061.45 | 8097.97 | 0.000 |
| 450.00 | 3372.90 | 1063949 | 178783 | 3.373 | 0.00 | 172.246 |
| 0 | 3352.53 | -3342.06 | 455.09 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -29.09 | 1.59 | 0.000 | 0.00 | 169.127 |
| 0.00 | 0.90 | 29.14 | 2524041 | 1061.45 | 6673.53 | 0.000 |
| 500.00 | 4833.06 | 860232 | 200627 | 4.833 | 0.00 | 174.546 |
| 0 | 3352.53 | -4811.19 | 459.35 | 0.000 | 0.00 | 3.608 |
| 1260928 | 258942 | -29.64 | 1.58 | 0.000 | 0.00 | 171.487 |
| 0.00 | 0.92 | 29.68 | 2524041 | 1061.45 | 5213.38 | 0.000 |
| 550.00 | 6330.30 | 582284 | 222960 | 6.330 | 0.00 | 175.785 |
| 0 | 3352.53 | -6313.18 | 465.29 | 0.000 | 0.00 | 3.608 |
| 1260929 | 258942 | -30.41 | 1.59 | 0.000 | 0.00 | 172.787 |
| 0.00 | 0.94 | 30.46 | 2524041 | 1061.45 | 3716.14 | 0.000 |
| 600.00 | 7875.27 | 228168 | 245959 | 8.046 | 5.59 | 176.557 |
| 0 | 3352.53 | -7861.05 | 473.02 | 0.222 | 13.11 | 177.230 |
| 1261218 | 258939 | 31.55 | 1.91 | 0.000 | 0.00 | 173.622 |
| 0.12 | 0.98 | 31.48 | 2524041 | 1062.51 | 2172.22 | 0.000 |
| 610.00 | 8181.99 | 148004 | 250655 | 7.650 | 125.88 | 176.677 |
| 0 | 3352.53 | -8168.23 | 474.30 | 0.228 | 303.68 | 177.363 |
| 1259739 | 258937 | 28.76 | 1.84 | 0.000 | 0.00 | 0.012 |
| 3.07 | 0.89 | 31.72 | 2524041 | 1071.31 | 1856.74 | 0.000 |
| 620.00 | 8175.25 | 65502 | 255339 | 8.431 | 5780.33 | 176.790 |
| 0 | 3352.53 | -8162.43 | 457.77 | 0.218 | 13323.83 | 177.489 |
| 1165421 | 258915 | -55.94 | 1.92 | 0.000 | 0.00 | 0.011 |
| 116.16 | -2.98 | 31.97 | 2524041 | 1396.01 | 1538.78 | 0.000 |
| 629.28 | 4096.89 | 4040 | 258722 | 3.722 | 17638.35 | 176.934 |
| 0 | 3352.53 | -4091.02 | 219.12 | 0.369 | 68718.94 | 177.642 |
| 268274 | 258762 | -627.38 | 1.72 | 0.000 | 0.00 | 0.000 |
| 1819.28 | -19.50 | 32.16 | 2524041 | 5771.53 | 1241.62 | 0.000 |

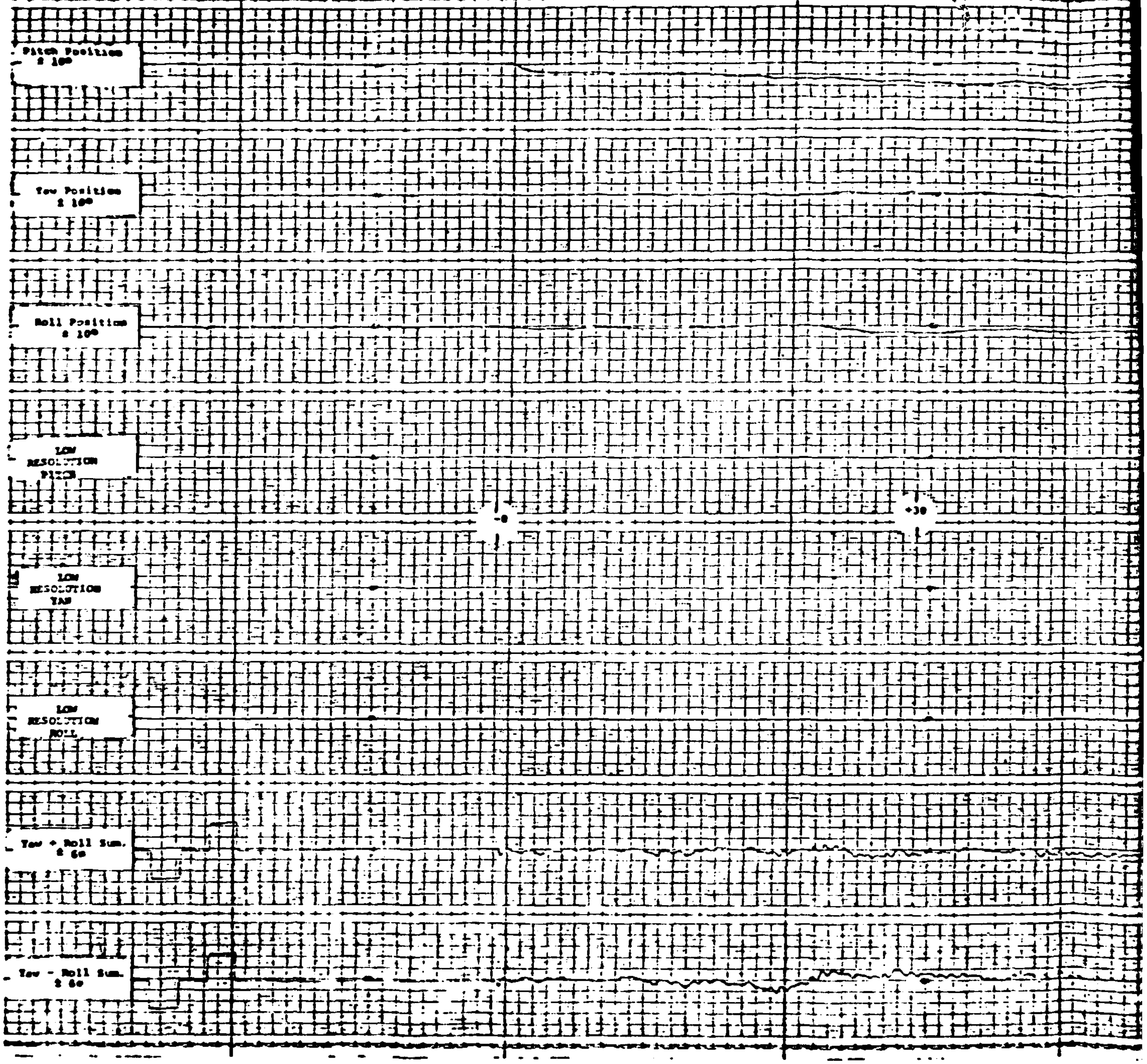
Section 4.3 continued

Telemetry data indicated that one of the separation monitors went blank at about +30 seconds. A cause for this abnormality could not be determined.

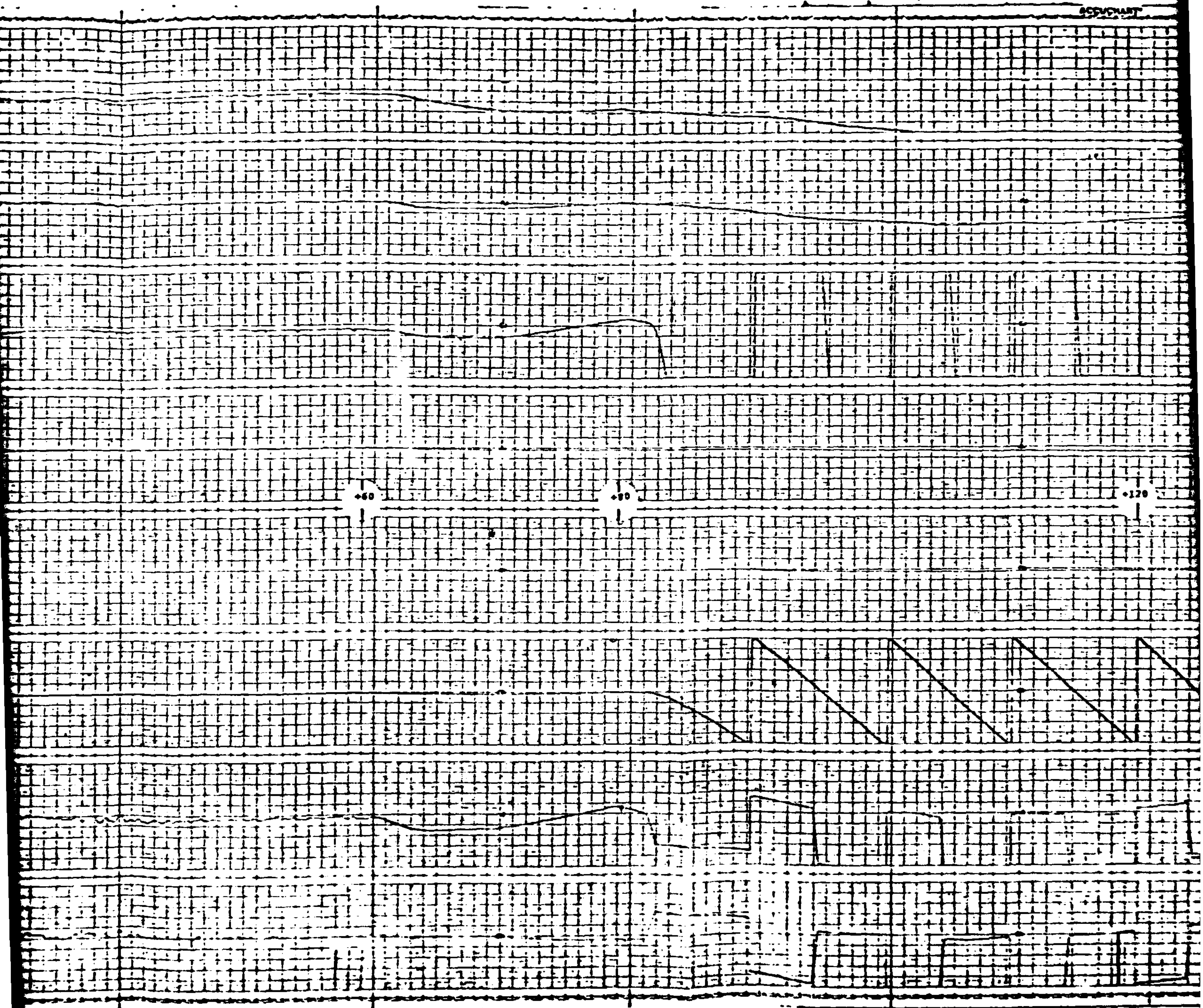
4.4 At the same time that separation occurred (T+80 sec.), the Booster Roll Jet System was actuated. Analysis of the available data indicates that two(2) seconds after separation, the spent Booster was rolling at a rate of $10.07^{o}$/sec.

4.5 A peak acceleration of 8.1 g was experienced during the flight. Figure 4-7 is a copy of the telemetry data for the vehicle Logitudinal Accelerometer.

4.6 The recovery system, through its pre-set baro-sensing system, was activated and functioned as designed. Minimum damage was inflicted on the recovered module.

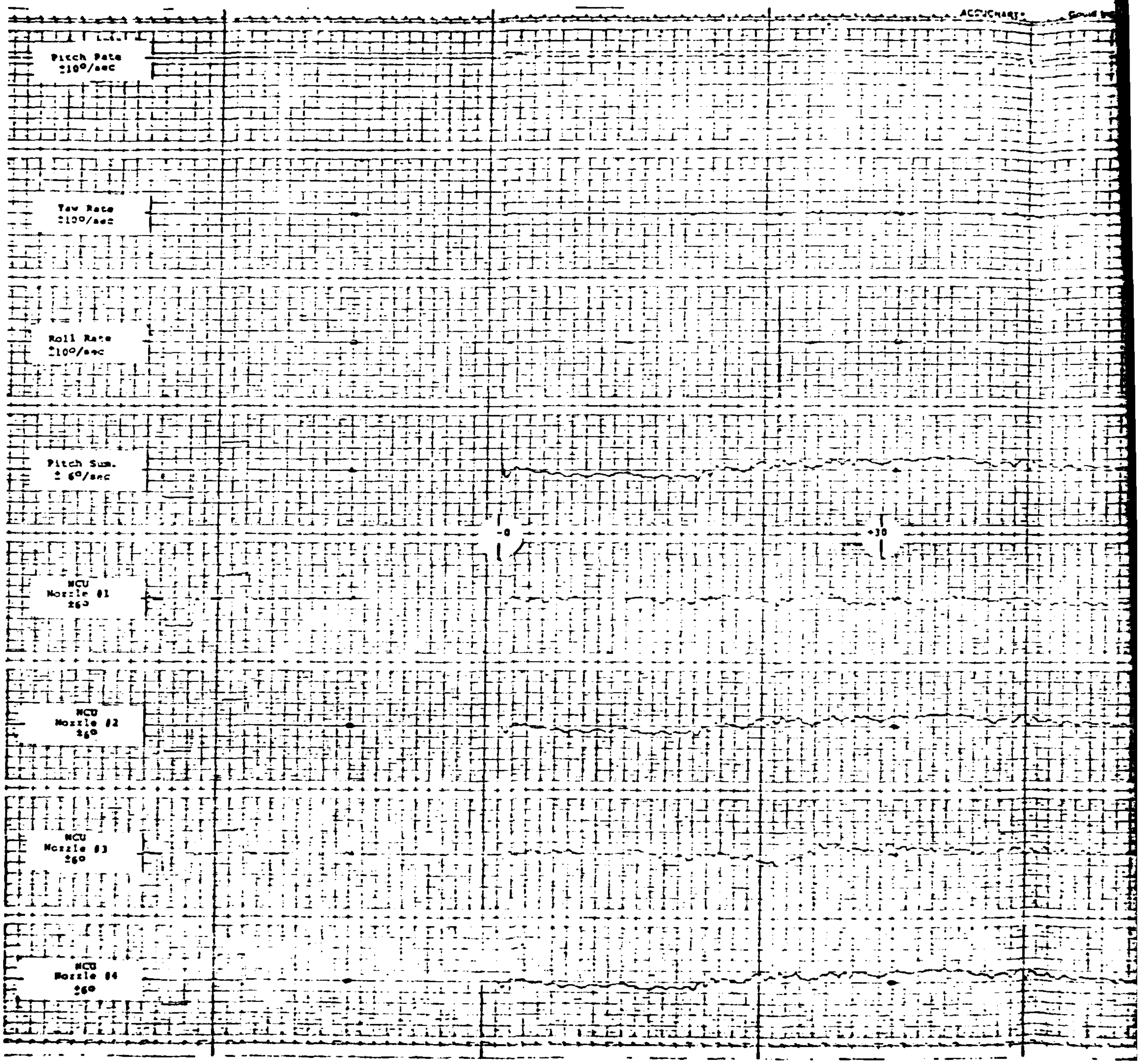

ACCUCHART
Pitch Position
Yaw Position
Roll Position
LOW RESOLUTION PITCH
LOW RESOLUTION YAW
LOW RESOLUTION ROLL
Yaw + Roll Sum.
Yaw - Roll Sum.
+30

1




2

Fig. 4-1


ACCUCHART
Pitch Rate
±10°/sec
Yaw Rate
±10°/sec
Roll Rate
±10°/sec
Pitch Sum.
± 6°/sec
-0
+30
NCU
Nozzle #1
±6°
NCU
Nozzle #2
±6°
NCU
Nozzle #3
±6°
NCU
Nozzle #4
±6°


2

Fig. 4-2

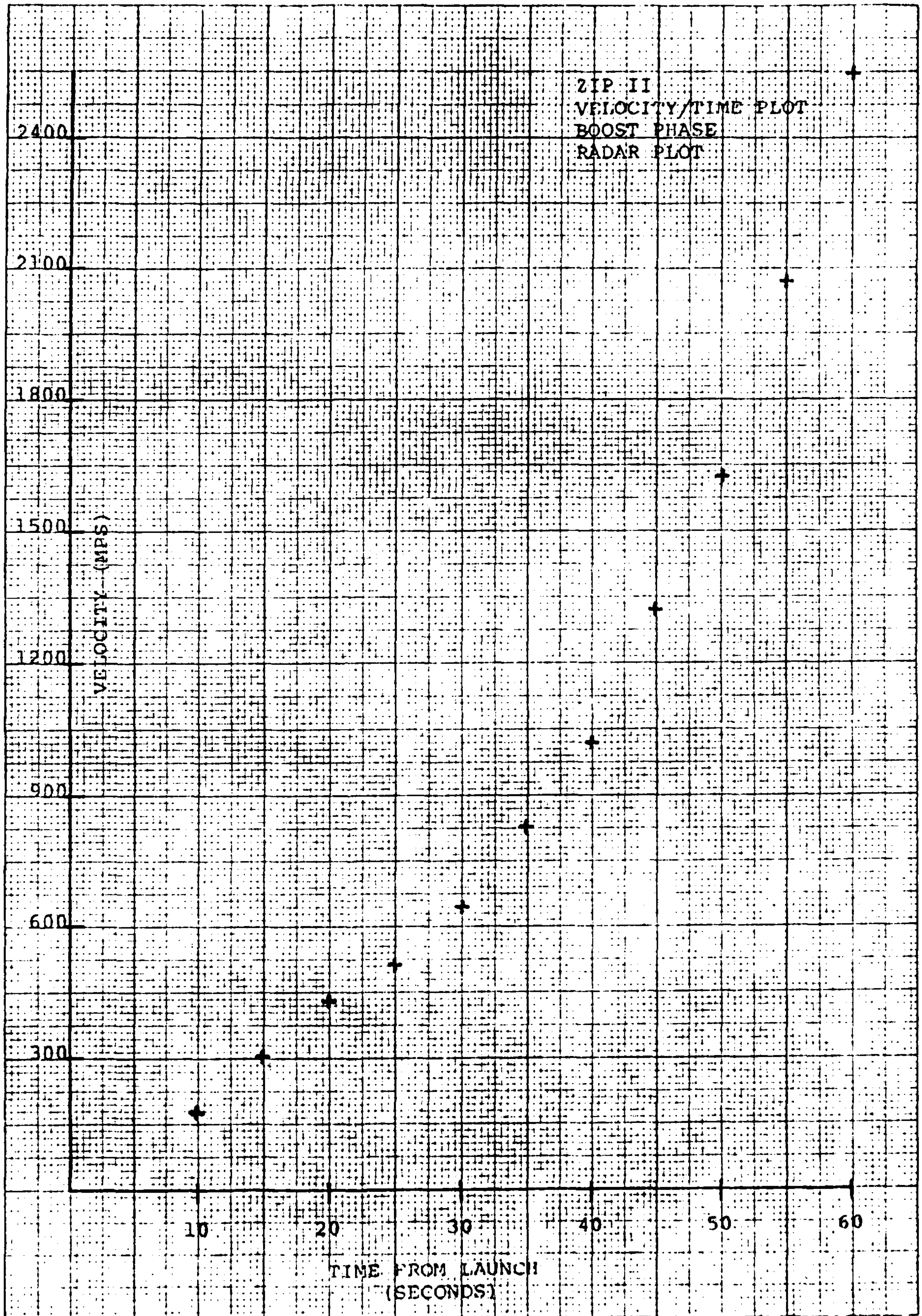

ZIP II
VELOCITY/TIME PLOT
BOOST PHASE
RADAR PLOT
VELOCITY (MPS)
2400
2100
1800
1500
1200
900
600
300
10
20
30
40
50
60
TIME FROM LAUNCH
(SECONDS)

Fig. 4-3

Fig. 4-4



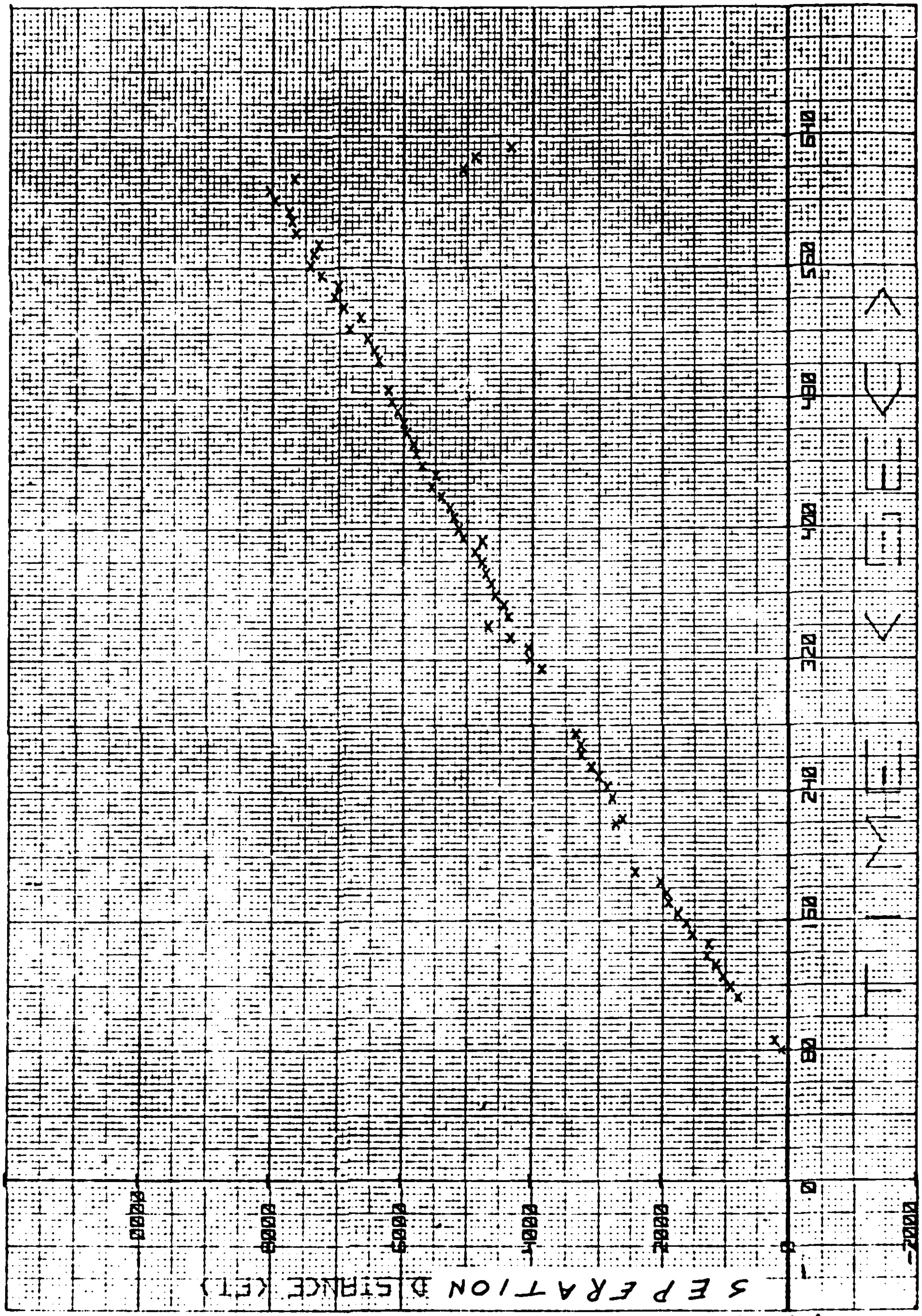
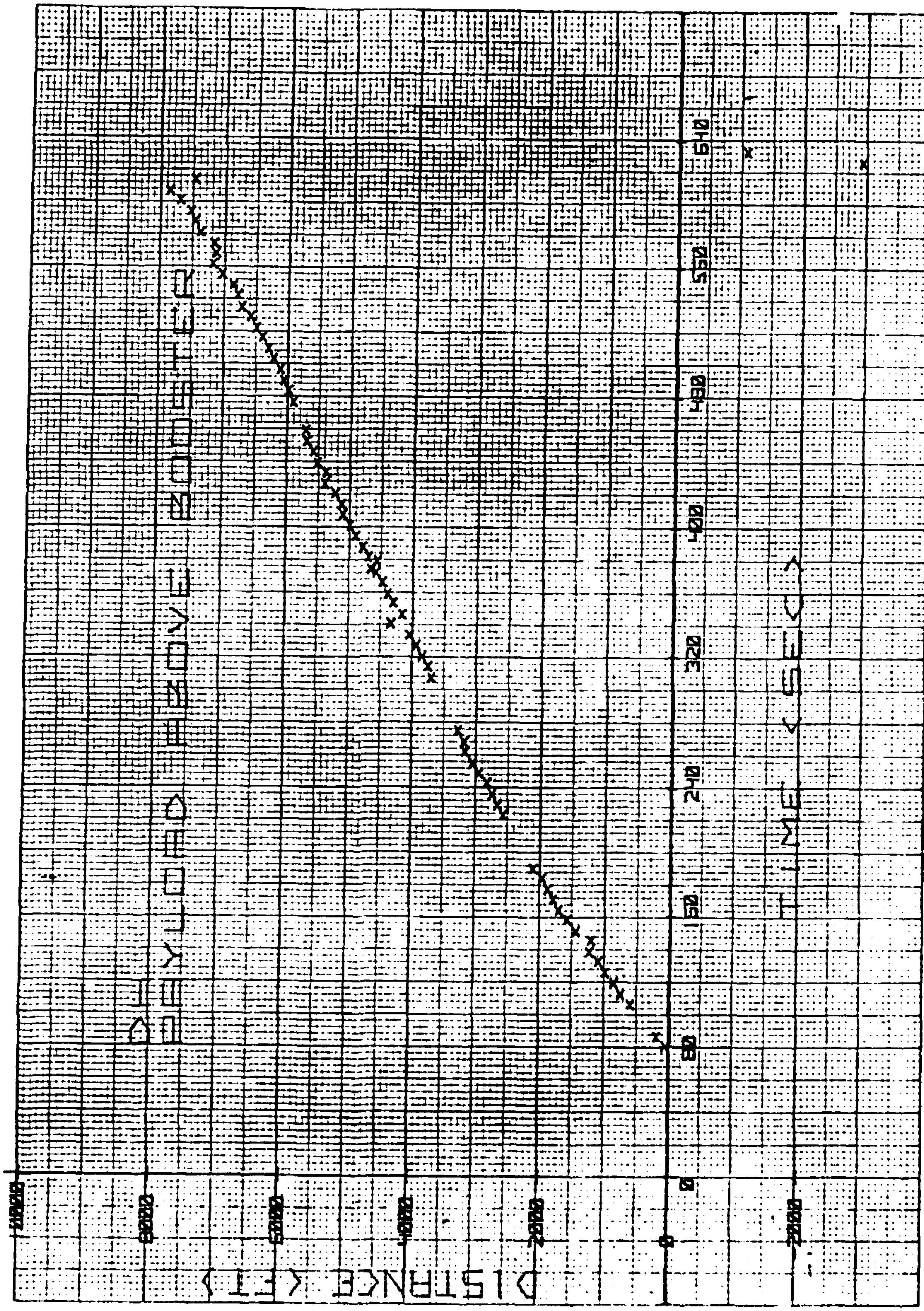
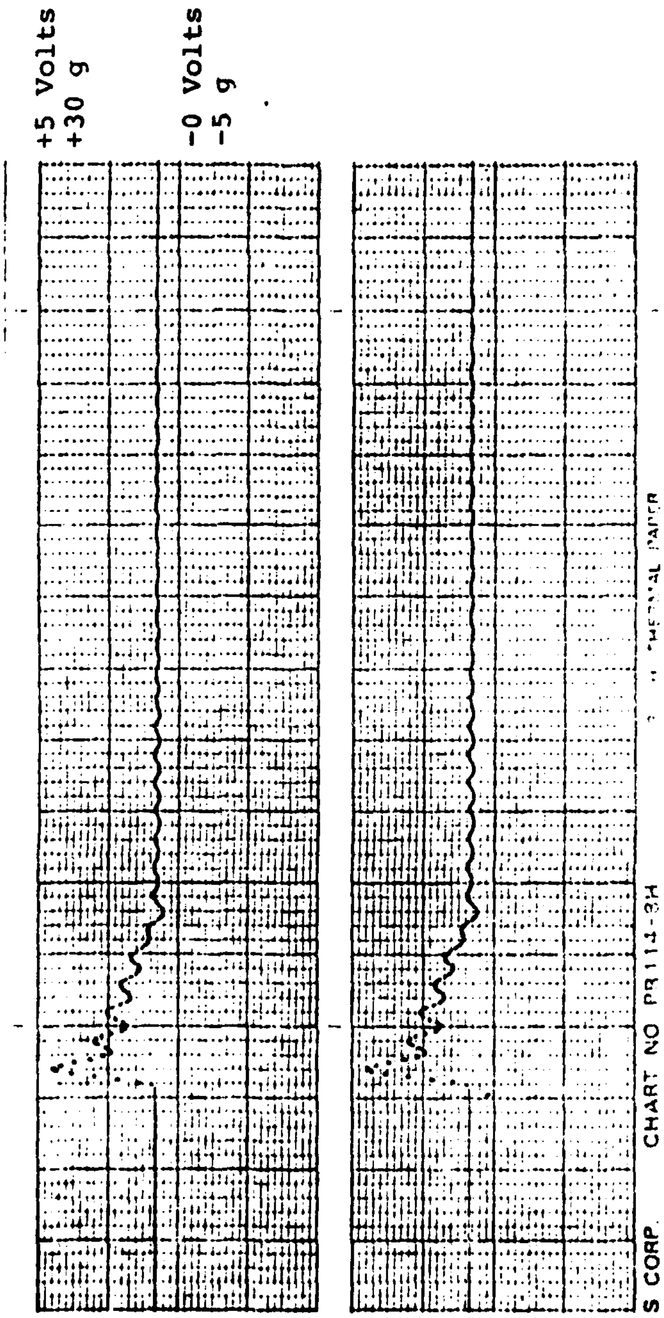

SEPERATION DISTANCE (FT)
TIME
10000
8000
6000
4000
2000
0
-2000
0
80
160
240
320
400
480
560
640

Fig. 4-4


PAYLOAD ABOVE BOOSTER
DISTANCE (FT)
TIME (SEC)
10000
8000
6000
4000
2000
0
-2000
0
80
160
240
320
400
480
560
640
Fig. 4-5



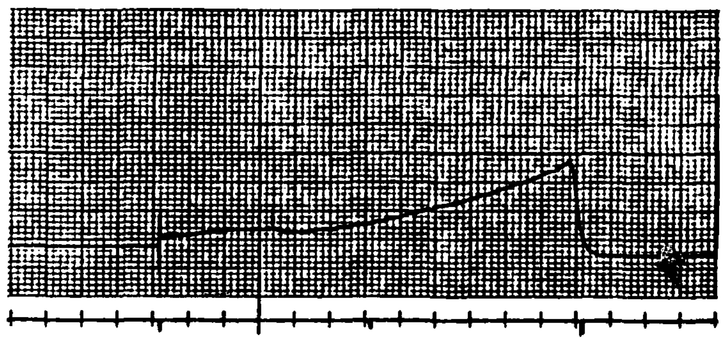

SEPARATION PULSE

13.5 FPS

Fig. 4-6

LONGITUDINAL ACCELERATION

-5 g to +30 g




BOOSTER ACCELERATION

Fig. 4-7

# SECTION 5.0

## IMPACT PREDICTION

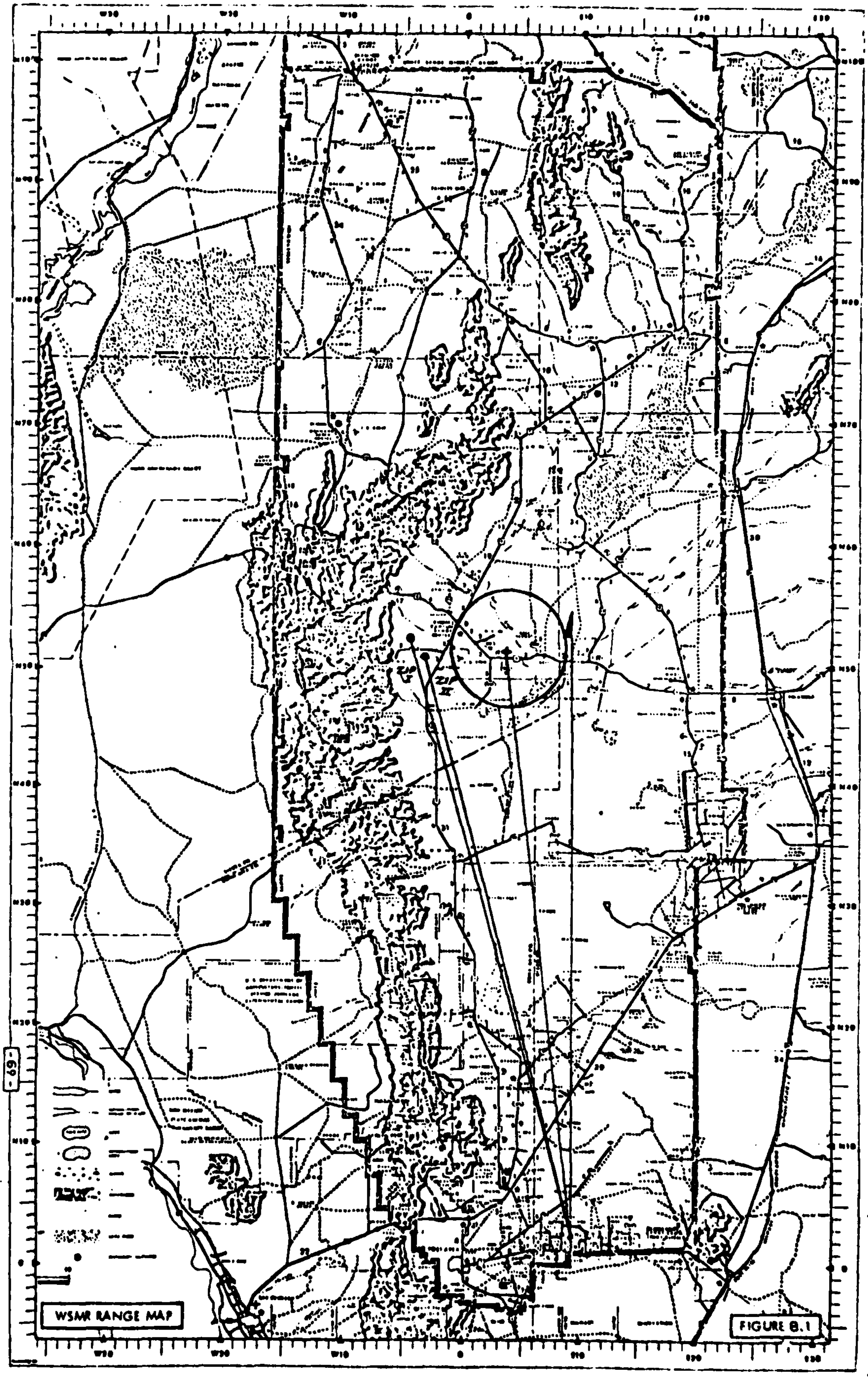
5.1 The ZIP II Booster impacted approximately seven miles West of the predicted impact point in Figure 5-1. Although this in itself is not serious, Space Vector has investigated the possible cause of this miss.

5.2 Analysis of the impact prediction techniques reveals that the prediction shown in Table 4-1 of 5.2 miles West was obtained by taking the non-rotating earth trajectory data at burnout and predicting the shift in impact point. If a rotating earth trajectory is performed, the predicted impact point is 8.0 miles West. If the effect of flying a MIDAS platform is then added, the predicted impact is 11.1 miles West.

5.3 The estimated CEP is 4 miles assuming normal MIDAS drift and alignment errors. This estimated CEP means that 50% of the flights would impact within a circle 4 miles in radius centered 11 miles West of the launch site. The RSS (Root Sum Square) three sigma dispersion is estimated at 13 miles.

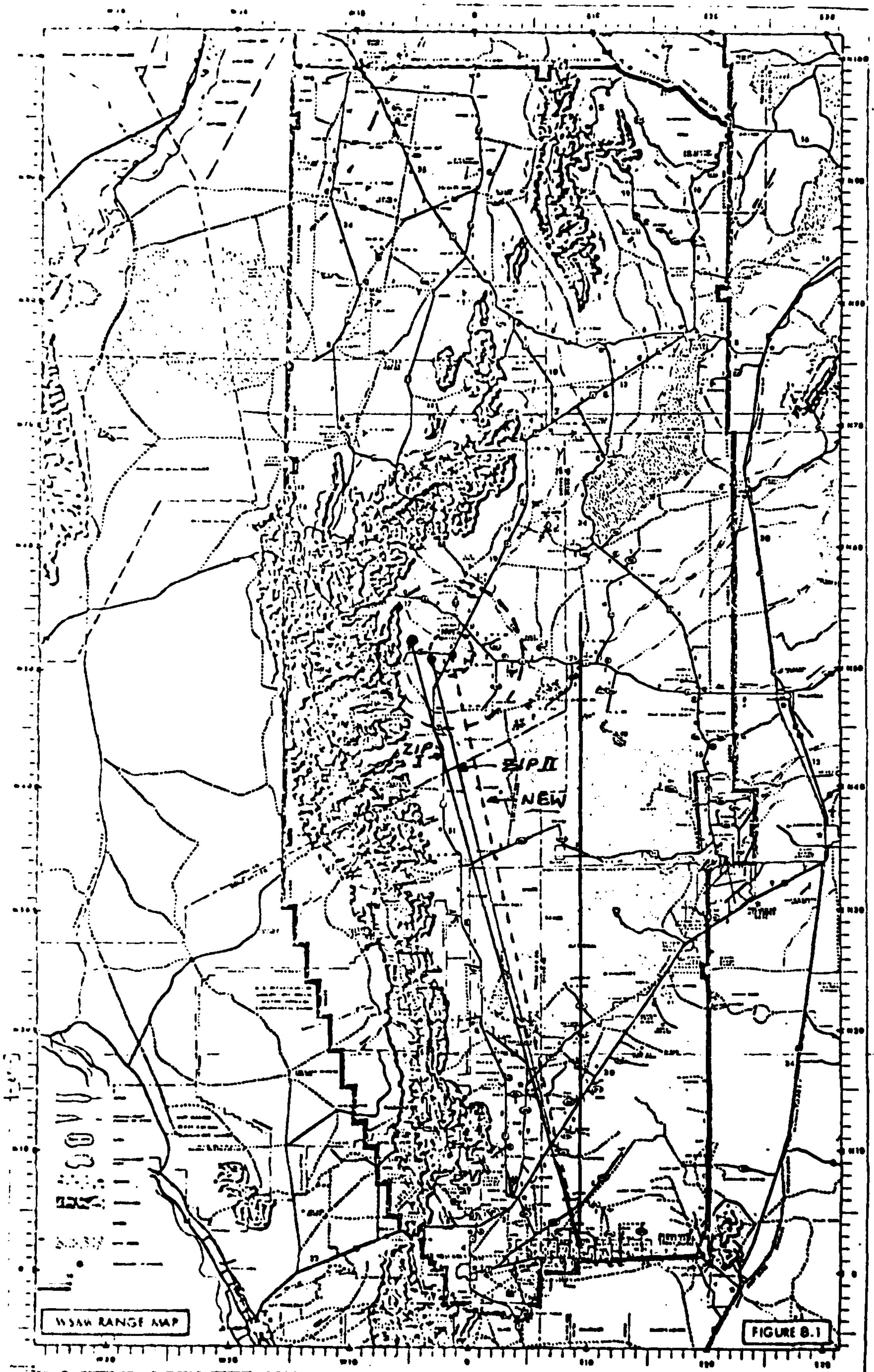
Further analysis of previous ARIES flights is required before a recommendation to change the launch heading can be made.

5.4 The corrected impact prediction is shown in Figure 5-2.




PREVIOUS IMPACT PREDICTION

Fig. 5-1




CORRECTED IMPACT PREDICTION

Fig. 5-2

DAT

ILM